Dyson's 90º Fillet Lap Weld From Theory Of Welds *Release 2*

Release 2 corrects the bad sttement of the normal stress on Y plane in release 1, since there are two welds

$\sigma_u := 260 \cdot \mathrm{MPa}$ yield strength of the base metal

Theory

- greek letters refer to stresses on throat plane
- all stresses are assumed at factored level
- stresses, even in the vertical and horizontal planes determined as for a throat width dimension
- from tensorial theory...

$$\sigma(n, t_I) := \frac{t_I + n}{\sqrt{2}}$$

σ normal to throat's plane

n stress in vertical Face (from Horizontal Load)

$$\tau_I(n, t_I) := \frac{t_I - n}{\sqrt{2}}$$

perpendicular to edge
in respective plane

$$\tau_{II}(t_{II}) := t_{II}$$

parallel to edge in
respective plane

n, t_I y t_{II} determined on a throat width but in the vertical and horizontal faces of the fillet weld

$$\sigma_{co}(n, t_I, t_{II}) := \sqrt{\sigma(n, t_I)^2 + 1.8 \cdot \left(\tau_I(n, t_I)^2 + \tau_{II}(t_{II})^2\right)}$$ tension of comparison

$$\sigma_{co}(n, t_I, t_{II}) \le \sigma_u$$ the check the weld

With this theory any fillet weld can be checked (but sometimes experimental reductions are applied).
Sole requirement of the theory is the weld metal be at least as strong as the base metal.

Dyson's Lap Weld

$P := 250 \cdot kN$ factored horizontal load being met

$L := 20 \cdot cm$ distance between vertical faces of the fillet welds

$t_1 := 1 \cdot cm$ thickness of the top plate

$a_1 := 6 \cdot mm$ throat of the top fillet weld

$b_1 := 20 \cdot cm$ effective length of the top fillet weld (add $2 \cdot a_1$ to this length to get the physical one)

$t_2 := 1 \cdot cm$ thickness of the bottom plate

$a_2 := 6 \cdot mm$ throat of the bottom fillet weld

$b_2 := 20 \cdot cm$ effective length of the bottom fillet weld (add $2 \cdot a_2$ to this length to get the physical one)

For generality, I won't assume the legs of the welds equal the thicknesses of the plates.
Also, for the acting pair I will count the horizontal forces centered on the respective plates, this being conservative in giving bigger initial and then equilibrating moment.
Then...

Stresses on the Top Fillet Weld (XY axes)

$$n_{top} := \frac{P \cdot \frac{a_1 \cdot b_1}{a_1 \cdot b_1 + a_2 \cdot b_2}}{b_1 \cdot a_1}$$

stress on vertical plane from horizontal force (share of load since there are two welds) meeting the horizontal force (assumption)

$$t_{I\_top} := \frac{\frac{P \cdot \frac{t_1 + t_2}{2}}{L}}{b_1 \cdot a_1}$$

tangential stress in vertical plane from vertical force as derived from pair

$t_{II\_top} := 0 \cdot MPa$ no tangential stress parallel to the edge of the fillets since no force

Stresses on the Bottom Fillet Weld (XY axes)

$$n_{bottom} := \frac{P \cdot \frac{a_2 \cdot b_2}{a_1 \cdot b_1 + a_2 \cdot b_2}}{b_2 \cdot a_2}$$

stress on vertical plane from horizontal force (share of load since there are two welds) meeting the horizontal force (assumption)

$$t_{I\_bottom} := \frac{\frac{P \cdot \frac{t_1 + t_2}{2}}{L}}{b_2 \cdot a_2}$$

tangential stress in vertical plane from vertical force as derived from pair

$$t_{II\_bottom} := 0 \cdot MPa$$

no tangential stress parallel to the edge of the fillets since no force

Ratios to Ultimate Strength of Top and Bottom Fillet Welds

$$\frac{\sigma_{co}\left(n_{top}, t_{I\_top}, t_{II\_top}\right)}{\sigma_u} = 0.46$$

must be less than or at most equal to 1 for OK

$$\frac{\sigma_{co}\left(n_{bottom}, t_{I\_bottom}, t_{II\_bottom}\right)}{\sigma_u} = 0.46$$

must be less than or at most equal to 1 for OK